UltraTech
Group of Labs

31040/SIT

A96/TH/0093

Canada
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entela

00-034

Mar. 03, 2003

TIMCO ENGINEERING INC.
P O BOX 370
849 N.W. STATE ROAD 45
NEWBERRY, FLORIDA
USA, 32669

Subject: **FCC Certification Authorization Application under FCC PART 15, Subpart C, Sec. 15.209 - Low Power Transmitter operating at 125 kHz and Sec. 15.231(e) - Momentarily Operation at 433.92 MHz.**

Product: **Exciter**
Model No.: **EX21**
FCC ID: **PQG-EX21**

Dear Sir/Madam

Enclosed you will find copy of the engineering report for test repeated with the 24 Vac supply input. If you have any queries, please do not hesitate to contact us.

If you have any queries, please do not hesitate to contact us.

Yours truly,

Tri Minh Luu, P. Eng.,
V.P., Engineering

Encl

3000 Bristol Circle,
Oakville, Ontario, Canada
L6H 6G4

Telephone (905) 829-1570
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Website: www.ultratech-labs.com
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00-034

Mar. 03, 2003

Lyngsoe Industries Ltd.
5570 Kennedy Road, Unit B
Mississauga, Ontario
Canada, L4Z 2A9

Attn.: **Don Ferguson**

Subject: **FCC Certification Application Testing under FCC PART 15, Subpart C, Sec. 15.209 - Low Power Transmitter operating at 125 kHz and Sec. 15.231(e) - Momentarily Operation at 433.92 MHz.**

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Email: vic@ultratech-labs.com

ENGINEERING TEST REPORT

Exciter
Model No.: EX21
FCC ID: PQG-EX21

Applicant:

Lyngsoe Industries Ltd.
5570 Kennedy Road, Unit B
Mississauga, Ontario
Canada, L4Z 2A9

In Accordance With

FEDERAL COMMUNICATIONS COMMISSION (FCC)
PART 15, SUBPART C, Sections 15.209 & 15.231(e)
Low Power Transmitter & Momentarily Operation (125 kHz & 433.92 MHz)

UltraTech's File No.: LYT-010F15C231

This Test report is Issued under the Authority of Tri M. Luu, Professional Engineer, Vice President of Engineering UltraTech Group of Labs Date: Mar. 03, 2003	
Report Prepared by: Dan Huynh Issued Date: Mar. 03, 2003	Tested by: Hung Trinh, RFI Technician Test Dates: Mar. 01 - 02, 2003

- *The results in this Test Report apply only to the sample(s) tested, and the sample tested is randomly selected.*
- *This report must not be used by the client to claim product endorsement by NVLAP or any agency of the US Government.*

UltraTech

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TABLE OF CONTENTS

EXHIBIT 1. SUBMITTAL CHECK LIST

Annex No.	Exhibit Type	Description of Contents	Quality Check (OK)
--	Test Report	▪ Exhibit 1: Submittal check lists ▪ Exhibit 2: Introduction ▪ Exhibit 3: Performance Assessment ▪ Exhibit 4: EUT Operation and Configuration during Tests ▪ Exhibit 5: Summary of test Results ▪ Exhibit 6: Measurement Data ▪ Exhibit 7: Measurement Uncertainty ▪ Exhibit 8: Measurement Methods	OK
1	Test Setup Photos	Radiated Emissions Test Setup Photos	Photos of Test setup of the AC power line conducted emissions
2	External Photos of EUT	External EUT Photos	Refer to original application
3	Internal Photos of EUT	Internal EUT Photos	Refer to original application
4	Cover Letters	▪ Letter from Ultratech for Certification Request ▪ Letter from the Applicant to appoint Ultratech to act as an agent ▪ Letter from the Applicant to request for Confidentiality Filing	Refer to original application
5	ID Label/Location Info	▪ ID Label ▪ Location of ID Label	Refer to original application
6	Block Diagrams	Exciter EX21 Block Diagram	Refer to original application
7	Schematic Diagrams	▪ Exciter EX21 Electrical Schematic ▪ LF Amplifier LFA21 Electrical Schematic	Refer to original application
8	Parts List/Tune Up Info	▪ Exciter EX21 General Assembly ▪ LF Amplifier LFA21 Component Assembly ▪ BOM - PCB/Encl. Exciter EX21 (P/N 500010) ▪ BOM - LF Amplifier LFA21 (P/N 500006)	Refer to original application
9	Operational Description	Theory of Operation	Refer to original application
10	RF Exposure Info	--	N/A
11	Users Manual	RFI D System S21 User's Guide	Refer to original application

EXHIBIT 2. INTRODUCTION

2.1. SCOPE

Reference:	FCC Part 15, Subpart C, Sections 15.209 and 15.231(e)
Title:	Telecommunication - Code of Federal Regulations, CFR 47, Part 15
Purpose of Test:	To gain FCC Certification Authorization for Low Power Transmitter operating at 125 kHz and Sec. 15.231(e) - Momentarily Operation at 433.92 MHz .
Test Procedures:	Both conducted and radiated emissions measurements were conducted in accordance with American National Standards Institute ANSI C63.4 - American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.
Environmental Classification:	Light-industry, Industry or Commercial

2.2. RELATED SUBMITTAL(S)/GRANT(S)

None.

2.3. NORMATIVE REFERENCES

Publication	Year	Title
FCC CFR Parts 0-19	2001	Code of Federal Regulations – Telecommunication
ANSI C63.4	1992	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
CISPR 22 & EN 55022	1997 1998	Limits and Methods of Measurements of Radio Disturbance Characteristics of Information Technology Equipment
CISPR 16-1	1999	Specification for Radio Disturbance and Immunity measuring apparatus and methods
FCC Public Notice DA 00-705	2000	Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems
FCC Public Notice DA 00-1407	2000	Part 15 Unlicensed Modular Transmitter Approval

EXHIBIT 3. PERFORMANCE ASSESSMENT

3.1. CLIENT INFORMATION

APPLICANT	
Name:	Lyngsoe Industries Ltd.
Address:	5570 Kennedy Road, Unit B Mississauga, Ontario Canada, L4Z 2A9
Contact Person:	Donald Ferguson Phone #: (905) 501-1533 Fax #: (905) 501-1538 Email Address: dfe@lyngsoe-industries.com

MANUFACTURER	
Name:	Lyngsoe Industries Ltd.
Address:	5570 Kennedy Road, Unit B Mississauga, Ontario Canada, L4Z 2A9
Contact Person:	Donald Ferguson Phone #: (905) 501-1533 Fax #: (905) 501-1538 Email Address: dfe@lyngsoe-industries.com

3.2. EQUIPMENT UNDER TEST (EUT) INFORMATION

The following information (with the exception of the Date of Receipt) has been supplied by the applicant.

Brand Name:	Lyngsoe Industries Ltd.
Product Name:	Exciter
Model Name or Number:	EX21
Serial Number:	Pre-production sample
Type of Equipment:	Low Power Transmitter
Input Power Supply Type:	24 Vac or 25 Vdc nominal from a host system
Primary User Functions of EUT:	This equipment is part of the RFID System S21 and together with Reader RD21 creates a Reading Point for RFID Systems. The main function of the Exciter EX21 is to generate the LF field which will “excite” transponders PT21. Exciter EX21 incorporates also electronic blocks for self testing and for testing the UHF receiving capability of Reader RD21 (an UHF transmitter which simulates a transponder PT21).

3.3. EUT'S TECHNICAL SPECIFICATIONS

Transmitter @ 125 kHz	
Equipment Type:	Base station (fixed use)
Intended Operating Environment:	Commercial, light industry & heavy industry
RF Output Power Rating:	0.0
Operating Frequency Range:	125 kHz
Duty Cycle:	45.2%
25 dB Bandwidth:	9.29 kHz
Modulation Type:	Pulse modulation with recognition coding
Emission Designation:	9K29N0N
Antenna Connector Type:	Integral, permanently attached loop antenna

Transmitter @ 433.92 MHz	
Equipment Type:	Base station (fixed use)
Intended Operating Environment:	Commercial, light industry & heavy industry
RF Output Power Rating:	0.0
Operating Frequency Range:	433.92 MHz
Duty Cycle:	10.8%
20 dB Bandwidth:	40.0 kHz
Modulation Type:	Pulse modulation with recognition coding
Emission Designation:	40K0L1D
Antenna Connector Type:	Integral antenna (part of on the printed circuit board) housed inside the enclosure.

3.4. LIST OF EUT'S PORTS

None.

3.5. ANCILLARY EQUIPMENT

None.

3.6. GENERAL TEST SETUP

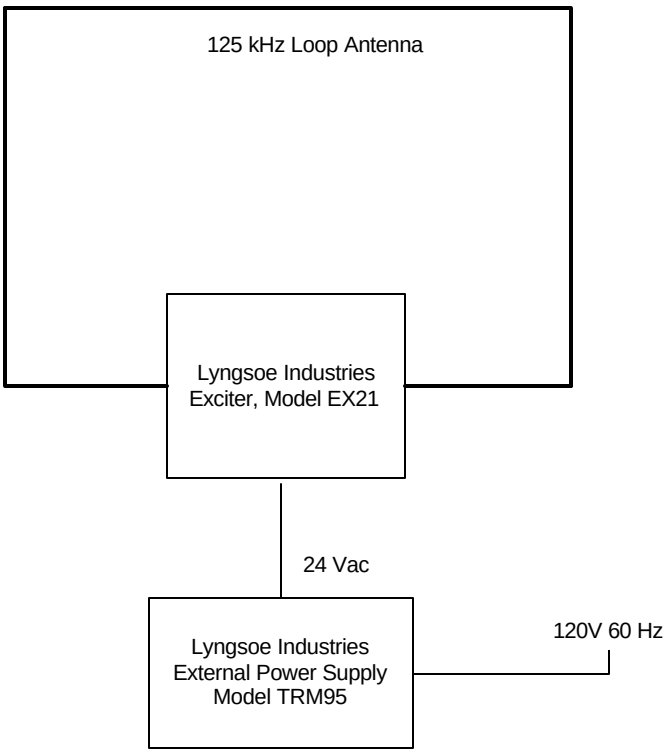


EXHIBIT 4. EUT OPERATION CONDITIONS AND CONFIGURATIONS DURING TESTS

4.1. CLIMATE TEST CONDITIONS

The climate conditions of the test environment are as follows:

Temperature:	21°C
Humidity:	51%
Pressure:	102 kPa
Power Input Source:	24 Vac

4.2. OPERATIONAL TEST CONDITIONS & ARRANGEMENT FOR TESTS

Operating Modes:	The EUT was set to transmit continuously by means of special setting of jumpers on the printed circuit board for testing purpose only.
Special Test Software:	None
Special Hardware Used:	None
Transmitter Test Antenna:	The EUT is tested with the antenna fitted in a manner typical of normal intended use as an integral antenna equipment.

Transmitter Test Signals	
Frequencies:	125 kHz & 433. 92 MHz

EXHIBIT 5. SUMMARY OF TEST RESULTS

5.1. LOCATION OF TESTS

All of the measurements described in this report were performed at Ultratech Group of Labs located in the city of Oakville, Province of Ontario, Canada.

- AC Powerline Conducted Emissions were performed in UltraTech's shielded room, 16'(L) by 12'(W) by 12'(H).

- Radiated Emissions were performed at the Ultratech's 3 Meter Open Field Test Site (OFTS) situated in the Town of Oakville, province of Ontario.

The above sites have been calibrated in accordance with ANSI C63.4, and found to be in compliance with the requirements of Sec. 2.948 of the FCC Rules. The descriptions and site measurement data of the Oakville Open Field Test Site has been filed with FCC office (FCC File No.: 31040/SIT 1300B3) and Industry Canada office (Industry Canada File No.: IC2049). Last Date of Site Calibration: Aug. 10, 2002.

5.2. APPLICABILITY & SUMMARY OF EMC EMISSION TEST RESULTS

FCC 15.209 - LOW POWER TRANSMITTER @ 125 kHz		
FCC Sections	**Test Requirements**	**Compliance (Yes/No)**
15.203	Antenna Requirement	Yes. Permanently attached loop antenna.
15.209 & 15.205	Transmitter Radiated Emissions - Fundamental, Harmonic and Spurious	Yes
	25 dB Bandwidth	Yes
15.207	AC Power Line Conducted Emissions Measurements (Transmit & Receive)	Yes. Tested with the external power supply that is provided for the Lyngsoe Industries host systems which operates with EX21 Exciter

FCC 15.231(e) - MOMENTARILY TRANSMITTER @ 433.92 MHz		
FCC Sections	**Test Requirements**	**Compliance (Yes/No)**
15.203	Antenna Requirement	Yes. Integral antenna (part of the printed circuit board) housed inside the enclosure.
15.231(e)(a)	Provisions of FCC 15.231(e)	Yes
15.231(e)(a) & (b)	Transmitter Radiated Emissions - Fundamental, Harmonic and Spurious	Yes
15.231(e)(c)	20 dB Bandwidth	Yes
15.207	AC Power Line Conducted Emissions Measurements (Transmit & Receive)	Yes. Tested with the external power supply that is provided for the Lyngsoe Industries host systems which operates with EX21 Exciter

Unintentional Radiators
The digital circuit portion of the EUT has been tested and verified to comply with FCC Part 15, Subpart B, Class A Digital Devices. The engineering test report can be provided upon FCC requests.

5.3. MODIFICATIONS INCORPORATED IN THE EUT FOR COMPLIANCE PURPOSES

None.

EXHIBIT 6. MEASUREMENTS, EXAMINATIONS & TEST DATA FOR EMC EMISSIONS

6.1. TEST PROCEDURES

This section contains test results only. Details of test methods and procedures can be found in Exhibit 8 of this report, ANSI C63-4:1992 and FCC Public Notice @ DA 00-705 (March 30, 2000) – Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems.

6.2. MEASUREMENT UNCERTAINTIES

The measurement uncertainties stated were calculated in accordance with requirements of UKAS Document NIS 81 with a confidence level of 95%. Please refer to Exhibit 7 for Measurement Uncertainties.

6.3. MEASUREMENT EQUIPMENT USED

The measurement equipment used complied with the requirements of the Standards referenced in the Methods & Procedures ANSI C64-3:1992, FCC 15.209 and CISPR 16-1.

6.4. ESSENTIAL/PRIMARY FUNCTIONS AS DECLARED BY THE MANUACTURER

The essential function of the EUT is to correctly communicate data to and from radios over RF link.

6.5. AC POWERLINE CONDUCTED EMISSIONS @ FCC PART 15, SUBPART B, PARA.15.107(A)

6.5.1. Limits

The equipment shall meet the limits of the following table:

	CLASS B LIMITS		
Test Frequency Range (MHz)	**Quasi-Peak (dBmV)**	**Average* (dBmV)**	**Measuring Bandwidth**
0.15 to 0.5	66 to 56*	56 to 46*	RBW = 9 kHz VBW ≥ 9 kHz for QP VBW = 1 Hz for Average
0.5 to 5	56	46	RBW = 9 kHz VBW ≥ 9 kHz for QP VBW = 1 Hz for Average
5 to 30	60	50	RBW = 9 kHz VBW ≥ 9 kHz for QP VBW = 1 Hz for Average

* Decreasing linearly with logarithm of frequency

6.5.2. Method of Measurements

Refer to Exhibit 7 of this test report & ANSI C63-4:1992

6.5.3. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer/ EMI Receiver	Hewlett Packard	HP 8593EM	3412A00103	9 kHz – 26.5 GHz
Transient Limiter	Hewlett Packard	11947A	310701998	9 kHz – 200 MHz 10 dB attenuation
L.I.S.N.	EMCO	3825/2	89071531	9 kHz – 200 MHz 50 Ohms / 50 µH
12'x16'x12' RF Shielded Chamber	RF Shielding	…	..	…

6.5.4. Test Data

Remarks: The Lyngsoe Industries EX21 Exciter is powered by a powered by a 24 Vac from a separate host system supplied by Lyngsoe Industries. Therefore, the following AC powerline conducted emissions are tested with the Lyngsoe external power supply, Model TRM95, that is provided with Lyngsoe Industries host systems.

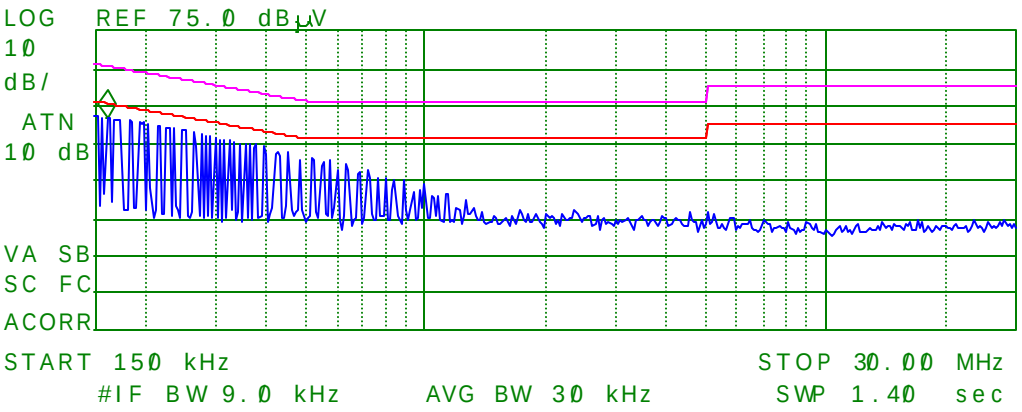
6.5.4.1. Test Configuration #1: The EX21 Exciter transmit 125 kHz RF Signal

FREQUENCY (MHz)	RF LEVEL (dBuV)	RECEIVER DETECTOR (P/QP/AVG)	QP LIMIT (dBuV)	AVG LIMIT (dBuV)	MARGIN (dB)	PASS/ FAIL	LINE TESTED (L1/L2)
0.16	45.8	QP	65.5	55.5	-19.7	PASS	L1
0.16	17.1	AVG	65.5	55.5	-38.4	PASS	L1
0.16	46.3	QP	65.5	55.5	-19.2	PASS	L2
0.16	17.2	AVG	65.5	55.5	-38.3	PASS	L2
The emissions were scanned from 150 kHz to 30 MHz at AC mains Terminal via a LISN, and all emissions less than 20 dB below the limits were recorded.							

AC POWER LINE CONDUCTED EMISSIONS MEASUREMENT PLOT			
Detector:[X] PEAK [X] QUASI-PEAK [X] AVERAGE		Temp:	Humidity:
Line Tested Hot	Line Voltage 120Vac	Test Tech: Phuong	Test Date: Mar. 13, 03
Standard FCC Class B	Comments: 125 kHz Modulated with 600Hz		

10:28 AM 3/13/03 Ultratech Group of Labs - Conducted Emissions

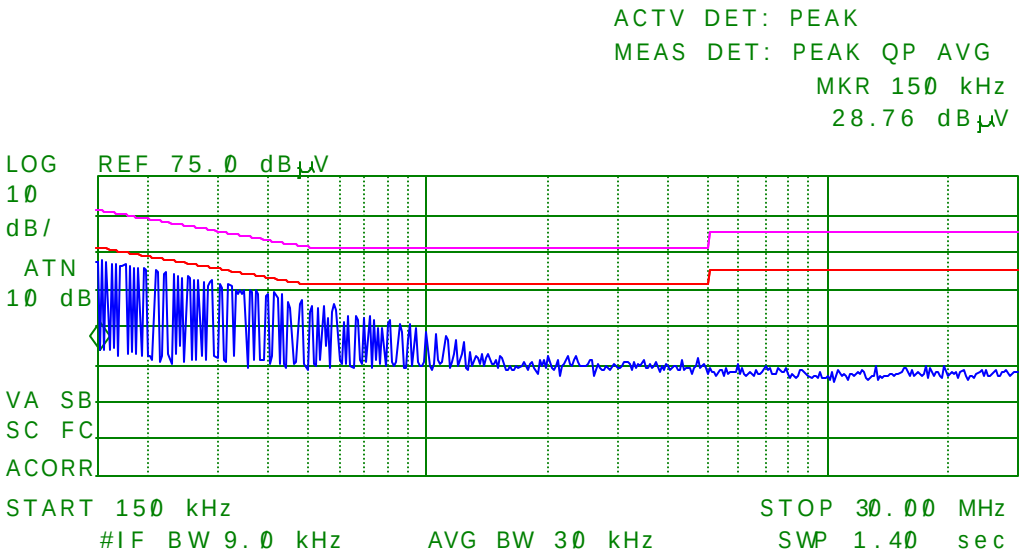
Signal	Freq (MHz)	PK Amp	QP Amp	AV Amp	AV△L2
1	0.160625	51.8	45.8	17.1	-38.4



AC POWER LINE CONDUCTED EMISSIONS MEASUREMENT PLOT			
Detector:[X] PEAK [X] QUASI-PEAK [X] AVERAGE		Temp:	Humidity:
Line Tested Neutral	Line Voltage 120Vac	Test Tech: Phuong	Test Date: Mar. 13, 03
Standard FCC Class B	Comments: 125 kHz Modulated with 600Hz		

10:22 AM 3/13/03 Ultratech Group of Labs - Conducted Emissions

Signal	Freq (MHz)	PK Amp	QP Amp	AV Amp	AV△L2
1	0.152125	52.3	46.3	17.2	-38.7



6.5.4.2. Test Configuration #2: The EX21 Exciter transmit 433.92 MHz RF Signal

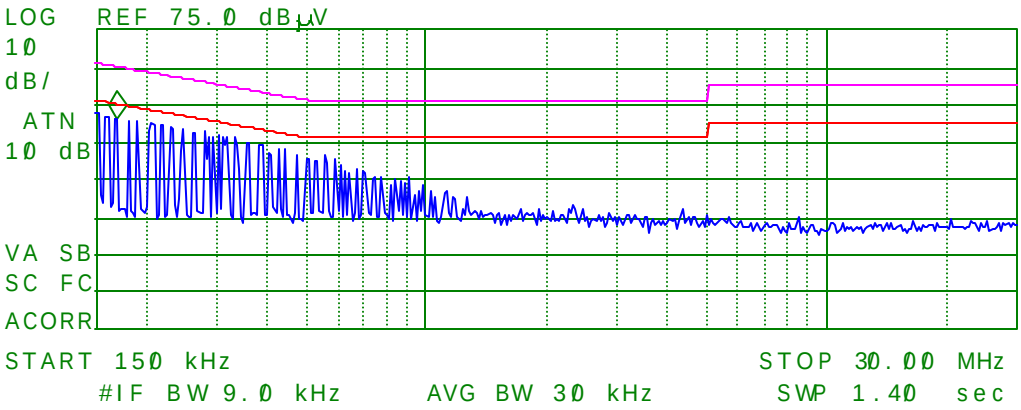
FREQUENCY (MHz)	RF LEVEL (dBuV)	RECEIVER DETECTOR (P/QP/AVG)	QP LIMIT (dBuV)	AVG LIMIT (dBuV)	MARGIN (dB)	PASS/ FAIL	LINE TESTED (L1/L2)
0.16	45.3	QP	65.5	55.5	-20.2	PASS	L1
0.16	16.3	AVG	65.5	55.5	-39.2	PASS	L1
0.16	46.0	QP	65.5	55.5	-19.5	PASS	L2
0.16	17.3	AVG	65.5	55.5	-38.2	PASS	L2
The emissions were scanned from 150 kHz to 30 MHz at AC mains Terminal via a LISN, and all emissions less than 20 dB below the limits were recorded.							

AC POWER LINE CONDUCTED EMISSIONS MEASUREMENT PLOT			
Detector:[X] PEAK [X] QUASI-PEAK [X] AVERAGE		Temp:	Humidity:
Line Tested Hot	Line Voltage 120Vac	Test Tech: Phuong	Test Date: Mar. 13, 03
Standard FCC Class B	Comments: 433.92 MHz Modulated with Data		

10:35 AM 3/13/03 Ultratech Group of Labs - Conducted Emissions

hp

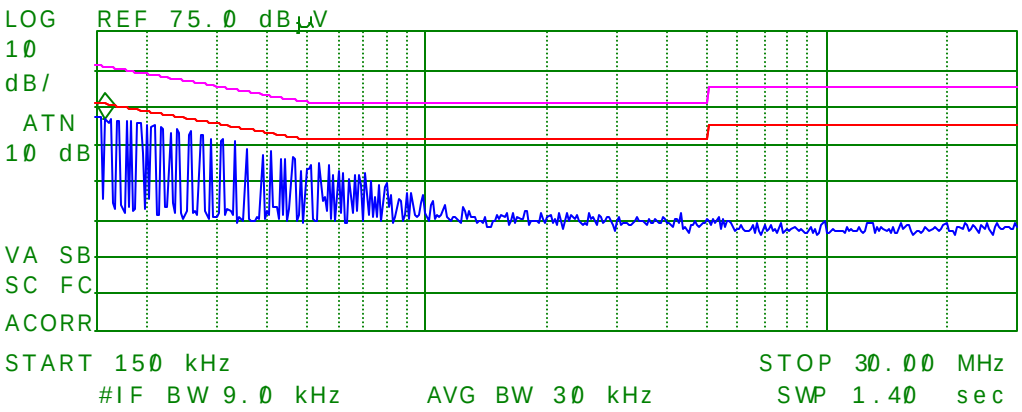
Signal	Freq (MHz)	PK Amp	QP Amp	AV Amp	AV△L2
1	0.171250	51.5	45.3	16.3	-38.6



AC POWER LINE CONDUCTED EMISSIONS MEASUREMENT PLOT			
Detector:[X] PEAK [X] QUASI-PEAK [X] AVERAGE		Temp:	Humidity:
Line Tested Neutral	Line Voltage 120Vac	Test Tech: Phuong	Test Date: Mar. 13, 03
Standard FCC Class B	Comments: 433.92 MHz Modulated with Data		

10:42 AM 3/13/03 Ultratech Group of Labs - Conducted Emissions

Signal	Freq (MHz)	PK Amp	QP Amp	AV Amp	AV△L2
1	0.158500	52.0	46.0	17.3	-38.3



6.6. 125 KHZ TRANSMITTER - FUNDAMENTAL & SPURIOUS EMISSIONS (RADIATED @ 3 METERS), FCC 47 CFR, SECTIONS 15.209 & 15.205

6.6.1. Limits

- The fundamental frequency shall not fall within any restricted frequency band specified in 15.205
- All rf other emissions shall not exceed the general radiated emission limits specified in @ 15.209(a).

FCC 47 CFR, Part 15, Subpart C, Section 15.205(a) - Restricted Frequency Bands

MHz	MHz	MHz	GHz
0.090–0.110	16.42–16.423	399.9–410	4.5–5.15
0.495–0.505	16.69475–16.69525	608–614	5.35–5.46
2.1735–2.1905	16.80425–16.80475	960–1240	7.25–7.75
4.125–4.128	25.5–25.67	1300–1427	8.025–8.5
4.17725–4.17775	37.5–38.25	1435–1626.5	9.0–9.2
4.20725–4.20775	73–74.6	1645.5–1646.5	9.3–9.5
6.215–6.218	74.8–75.2	1660–1710	10.6–12.7
6.26775–6.26825	108–121.94	1718.8–1722.2	13.25–13.4
6.31175–6.31225	123–138	2200–2300	14.47–14.5
8.291–8.294	149.9–150.05	2310–2390	15.35–16.2
8.362–8.366	156.52475–	2483.5–2500	17.7–21.4
8.37625–8.38675	156.52525	2655–2900	22.01–23.12
8.41425–8.41475	156.7–156.9	3260–3267	23.6–24.0
12.29–12.293	162.0125–167.17	3332–3339	31.2–31.8
12.51975–12.52025	167.72–173.2	3345.8–3358	36.43–36.5
12.57675–12.57725	240–285	3600–4400	Above 38.6
13.36–13.41	322–335.4		

FCC 47 CFR, Part 15, Subpart C, Section 15.209(a)
-- Field Strength Limits within Restricted Frequency Bands --

Frequency (MHz)	Field Strength Limits (microvolts/m)	Distance (Meters)
0.009 - 0.490	2,400 / F (KHz)	300
0.490 - 1.705	24,000 / F (KHz)	30
1.705 - 30.0	30	30
30 – 88	100	3
88 – 216	150	3
216 – 960	200	3
Above 960	500	3

6.6.2. Method of Measurements

Refer to Exhibit 8, Section 8.2 of this test report and **ANSI 63.4-1992, Para. 8** for detailed radiated emissions measurement procedures.

The following measurement procedures were also applied:

- Applies to harmonics/spurious that fall in the restricted bands listed in Section 15.205. the maximum permitted average field strength is listed in Section 15.209. A Pre-Amp and highpass filter are used for this measurement.
- For 9 kHz ≤ frequencies ≤ 150 kHz: RBW = 1 KHz, VBW ≥ 1 KHz, SWEEP=AUTO.
- For 150 MHz ≤ frequencies ≤ 30 MHz: RBW = 10 KHz, VBW ≥ 10 KHz, SWEEP=AUTO.
- For 30 MHz ≤ frequencies ≤ 1 GHz: RBW = 100 KHz, VBW ≥ 100 KHz, SWEEP=AUTO.
- For frequencies ≥ 1 GHz: RBW = 1 MHz, VBW = 1 MHz (Peak) & VBW = 10 Hz (Average), SWEEP=AUTO.
- If the emission is pulsed, modified the unit for continuous operation, then use the settings above for measurements, then correct the reading by subtracting the peak-average correction factor derived from the appropriate duty cycle calculation. See Section 15.35(b) and (c).

6.6.3. Test Arrangement

Please refer to general test setup in Section 3.6 for details of test arrangement.

6.6.4. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer/ EMI Receiver	Advantest	R3271	15050203	100 Hz to 32 GHz with external mixer for frequency above 32 GHz
Microwave Amplifier	Hewlett Packard	HP 83017A		1 GHz to 26.5 GHz
Biconilog Antenna	EMCO	3143	1029	20 MHz to 2 GHz
Horn Antenna	EMCO	3155	9701-5061	1 GHz – 18 GHz
Horn Antenna	EMCO	3160-09	..	18 GHz – 26.5 GHz
Horn Antenna	EMCO	3160-10	..	26.5 GHz – 40 GHz
Mixer	Tektronix	118-0098-00	..	18 GHz – 26.5 GHz
Mixer	Tektronix	119-0098-00	..	26.5 GHz – 40 GHz

6.6.5. Test Data

6.6.5.1. Radiated Emissions for a 125 kHz Transmitter with 24 Vac supply input

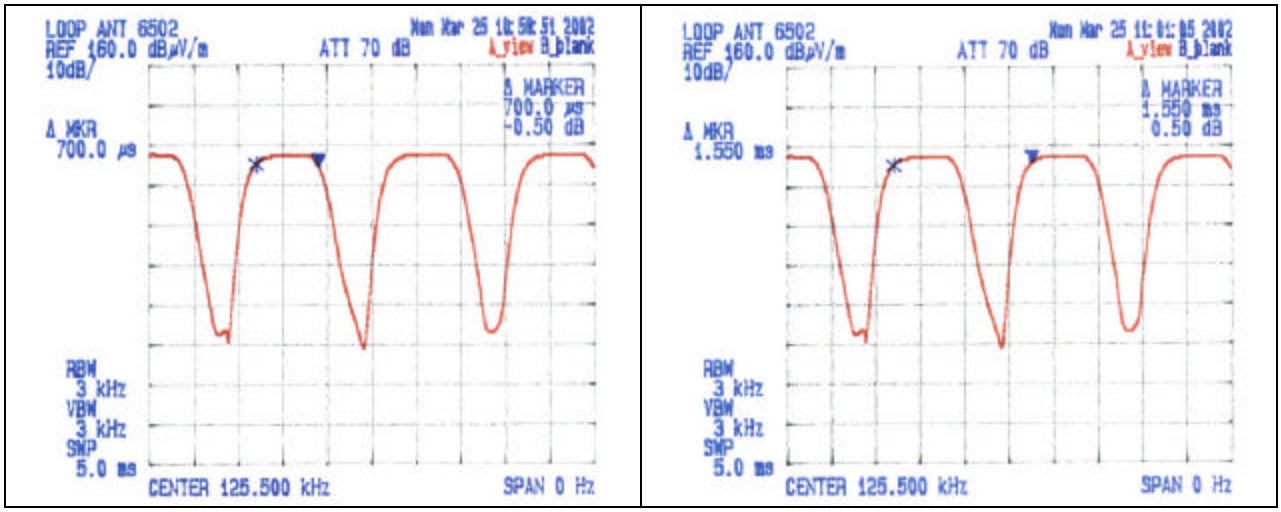
Frequency (MHz)	RF Peak Level (dBµV/m)	RF Avg Level (dBµV/m)	Antenna Plane (H/V)	Limit 15.209 (dBµV/m)	Limit Margin (dB)	Pass/ Fail	Distance (m)
0.125	**87.1**	**80.6**	**V**	**85.7**	**-5.1**	**Pass**	**30**
0.125	**76.8**	**69.9**	**H**	**85.7**	**-15.8**	**Pass**	**30**
57.30	23.2	--	V	40.0	-16.8	Pass	3
57.30	24.5	--	H	40.0	-4.5	Pass	3
86.70	21.0	--	V	40.0	-19.0	Pass	3
86.70	19.0	--	H	40.0	-21.0	Pass	3

- The emissions were scanned from 10 kHz to 1 GHz and all emissions within 20 dB below the limits were recorded.
- Highest measurements were recorded when the transmitter was tested with 3 different orthogonal positions as shown in photos # 1 to 3 in Annex 1.

Remarks:

(1) Duty Cycle = 0.7 mS/1.55 ms = 0.452
Peak-to-Average factor = 20*log (0.452) = -6.9 dB

Duty Cycle Measurements



(2) The 300m limit was converted to 30 m using cube factor (x) as it was found by measurements as follows:

- Maximum E-field at 10 meters distance: 116.69 dBµV/m (vertical)
- Maximum E-field at 30 meters distance: 87.1 dBµV/m (vertical)

Difference of measurement between 10 m & 30 m: $\Delta E = 116.7 - 87.1 = 29.6$ dB
$\Delta E = 20* \log(30/10)^x = 29.6$ dB or $x = 29.6/(20*\log 3) = 3.1$ or rounded of to 3
Therefore the limit for 125 kHz at 30 meters were calculated as:
$Limit_{30m} = Limit_{300m} + 20*\log(300/30)^3 = 20*\log[2400/125] + 60 = 85.67$ dBµV/m

6.7. 433.92 MHZ TRANSMITTER - RADIATED EMISSIONS @ 3 METERS, FCC 47 CFR, SECTIONS 15.231(E), 15.209 & 15.205

6.7.1. Limits

The RF radiated emissions measured at 3 Meter distance shall not exceed the field strength below:

Fundamental Frequency (MHz)	Average Field Strength Limits (µV/m)	
	Fundamental	Harmonic/Spurious
260 - 470 MHz	1,500 to 5,000	150 to 500

LIMIT @ 433.92 MHz = 72.9 dBµV/m at 3 meters
HARMONIC/SPURIOUS LIMIT (outside restricted bands) = 52.9 dBµV/m

All other emissions inside restricted bands specified in @ 15.205(a) shall not exceed the general radiated emission limits specified in @ 15.209(a)

Remarks:

- Applies to harmonics/spurious emissions that fall in the restricted bands listed in Section 15.205. The maximum permitted average field strength is listed in Section 15.209.
- @ **FCC 47 CFR, Section 15.237(c)** - The emission limits as specified above are based on measurement instrument employing an average detector. The provisions in **@15.35** for limiting peak emissions apply.

FCC 47 CFR, Part 15, Subpart C, Section 15.205(a) - Restricted Frequency Bands

MHz	MHz	MHz	GHz
0.090–0.110	16.42–16.423	399.9–410	4.5–5.15
0.495–0.505	16.69475–16.69525	608–614	5.35–5.46
2.1735–2.1905	16.80425–16.80475	960–1240	7.25–7.75
4.125–4.128	25.5–25.67	1300–1427	8.025–8.5
4.17725–4.17775	37.5–38.25	1435–1626.5	9.0–9.2
4.20725–4.20775	73–74.6	1645.5–1646.5	9.3–9.5
6.215–6.218	74.8–75.2	1660–1710	10.6–12.7
6.26775–6.26825	108–121.94	1718.8–1722.2	13.25–13.4
6.31175–6.31225	123–138	2200–2300	14.47–14.5
8.291–8.294	149.9–150.05	2310–2390	15.35–16.2
8.362–8.366	156.52475–	2483.5–2500	17.7–21.4
8.37625–8.38675	156.52525	2655–2900	22.01–23.12
8.41425–8.41475	156.7–156.9	3260–3267	23.6–24.0
12.29–12.293	162.0125–167.17	3332–3339	31.2–31.8
12.51975–12.52025	167.72–173.2	3345.8–3358	36.43–36.5
12.57675–12.57725	240–285	3600–4400	Above 38.6
13.36–13.41	322–335.4		

FCC 47 CFR, Part 15, Subpart C, Section 15.209(a)
-- Field Strength Limits within Restricted Frequency Bands --

Frequency (MHz)	Field Strength Limits (microvolts/m)	Distance (Meters)
0.009 - 0.490	2,400 / F (KHz)	300
0.490 - 1.705	24,000 / F (KHz)	30
1.705 - 30.0	30	30
30 – 88	100	3
88 – 216	150	3

216 – 960	200	3
Above 960	500	3

6.7.2. Method of Measurements

Refer to Exhibit 8, Section 8.2 of this test report & ANSI C63-4:1992

Applies to harmonics/spurious that fall in the restricted bands listed in Section 15.205. the maximum permitted average field strength is listed in Section 15.209. A Pre-Amp and highpass filter are used for this measurement.

- For measurements from 9 KHz to 150 KHz, set RBW = 200 Hz, VBW $\geq$ RBW, SWEEP=AUTO.
- For measurements from 150 KHz to 30 MHz, set RBW = 10 KHz, VBW $\geq$ RBW, SWEEP=AUTO.
- For measurements from 30 MHz to 1 GHz, set RBW = 100 KHz, VBW $\geq$ RBW, SWEEP=AUTO.
- For measurement above 1 GHz, set RBW = 1 MHz, VBW = 1 MHz, SWEEP=AUTO.

If the emission is pulsed, modified the unit for continuous operation, then use the settings above for measurements, then correct the reading by subtracting the peak-average correction factor derived from the appropriate duty cycle calculation. See Section 47 CFR §15.35(b) and (c).

6.7.3. Test Equipment List

Test Instruments	Manufacturer	Model No.	Serial No.	Frequency Range
Spectrum Analyzer/ EMI Receiver	Hewlett Packard	HP 8593EM	3412A00103	9 kHz – 26.5 GHz
Peak Power Meter & Peak Power Sensor	Hewlett Packard	8900 8481A	2131A00124 2551A01965	0.1-18 GHz 50 Ohms Input
Microwave Amplifier	Hewlett Packard	HP 83017A		1 GHz to 26.5 GHz
Active Loop Antenna	EMCO	6507	8906-1167	1 kHz – 30 MHz
Log Periodic/Bow-Tie Antenna	EMCO	3143	1029	20 - 1000 MHz
Horn Antenna	EMCO	3155	9701-5061	1 GHz – 18 GHz

6.7.4. Test Data

6.7.4.1. Radiated Emissions for a 125 kHz Transmitter with 24 Vac supply input

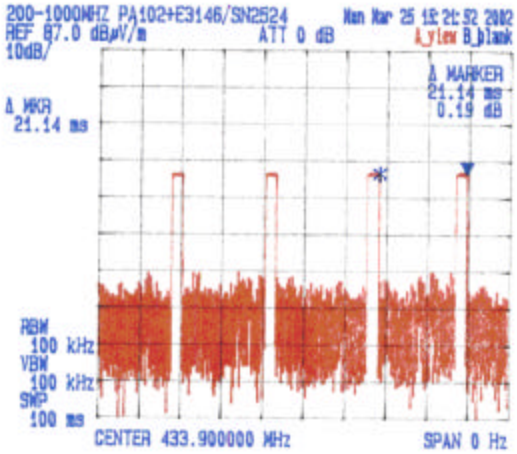
The emissions were scanned from 10 MHz to 5 GHz and all emissions less 20 dB below the limits were recorded.

Notes:
- Transmitter was placed in three different orthogonal positions for searching maximum field strength level.
- In the restricted band per FCC 15.205: Limit (2) per 15.209 is applied
- Outside the restricted band per FCC 15.205: Limit (1) per FCC 15.231(e) or Limit (2) per 15.209 whichever allows higher field strength emission, is applied.
- Duty Cycle = 4*2.7ms/100 ms = 0.108
- Peak-to-Average Factor = 20*log (0.108) = -19.3 dB

* Emissions fall in FCC restricted bands @ 15.205.

Frequency (MHz)	Peak E-Field @3m (dBµV/m)	Average E-Field @3m (dBµV/m)	Antenna Plane (V/H)	Average (1) Limit @3m (dBµV/m)	Restricted (2) Band Limits @3m (dBµV/m)	Margin (dB)
433.92	**59.0**	**39.7**	**V**	**72.9**	**--**	**-33.2**
433.92	**58.6**	**39.3**	**H**	**72.9**	**--**	**-33.6**
867.84	48.9	29.6	V	52.9	46.0	-23.2
867.84	47.2	27.9	H	52.9	46.0	-25.0
1735.68	50.2	30.9	V	52.9	54.0	-22.0
1735.68	48.5	29.2	H	52.9	54.0	-23.7

Duty Cycle Measurements



Duty cycle = $\frac{2.7\text{mS} \times 4}{100\text{mS}}$ = 0.108 or -19.3dB

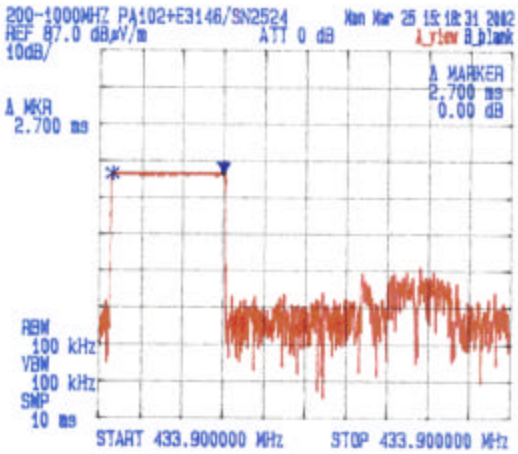


EXHIBIT 7. MEASUREMENT UNCERTAINTY

The measurement uncertainties stated were calculated in accordance with the requirements of NIST Technical Note 1297 and NIS 81 (1994)

7.1. RADIATED EMISSION MEASUREMENT UNCERTAINTY

CONTRIBUTION (Radiated Emissions)	PROBABILITY DISTRIBUTION	UNCERTAINTY (± dB)	
		3 m	10 m
Antenna Factor Calibration	Normal (k=2)	±1.0	±1.0
Cable Loss Calibration	Normal (k=2)	±0.3	±0.5
EMI Receiver specification	Rectangular	±1.5	±1.5
Antenna Directivit	Rectangular	+0.5	+0.5
Antenna factor variation with height	Rectangular	±2.0	±0.5
Antenna phase center variation	Rectangular	0.0	±0.2
Antenna factor frequency interpolation	Rectangular	±0.25	±0.25
Measurement distance variation	Rectangular	±0.6	±0.4
Site imperfections	Rectangular	±2.0	±2.0
Mismatch: Receiver VRC Γ_1 = 0.2 Antenna VRC Γ_R = 0.67(Bi) 0.3 (Lp) Uncertainty limits 20Log(1±$\Gamma_1\Gamma_R$)	U-Shaped	+1.1 -1.25	±0.5
System repeatability	Std. Deviation	±0.5	±0.5
Repeatability of EUT		-	-
Combined standard uncertainty	Normal	+2.19 / -2.21	+1.74 / -1.72
Expanded uncertainty U	Normal (k=2)	+4.38 / -4.42	+3.48 / -3.44

Calculation for maximum uncertainty when 3m biconical antenna including a factor of k=2 is used:

$U = 2u_c(y) = 2x(+2.19) = +4.38$ dB And $U = 2u_c(y) = 2x(-2.21) = -4.42$ dB

EXHIBIT 8. MEASUREMENT METHODS

8.1. GENERAL TEST CONDITIONS

The following test conditions shall be applied throughout the tests covered in this report.

8.1.1. Normal temperature and humidity

- Normal temperature: +15°C to +35°C
- Relative Humidity: +20% to 75%

The actual values during tests shall be recorded in the test report.

8.1.2. Normal power source

8.1.2.1. Mains Voltage

The nominal test voltage of the equipment to be connected to mains shall be the nominal mains voltage which is the declared voltage or any of the declared voltages for which the equipment was designed.

The frequency of test power source corresponding to the AC mains shall be between 59 Hz and 61 Hz.

8.1.3. Operating Condition of Equipment under Test

- All tests were carried out while the equipment operated at the following frequencies:
  - The lowest operating frequency,
  - The middle operating frequency and
  - The highest operating frequency

- Modulation were applied using the Test Data sequence
- The transmitter was operated at the highest output power, or in the case the equipment able to operate at more than one power level, at the lowest and highest output powers

8.2. RADIATED EMISSIONS

For both conducted and radiated measurements, the spurious emissions were scanned from the lowest frequency generated by the EUT or 10 MHz whichever is lower to 10th harmonic of the highest frequency generated by the EUT.

- The radiated emission measurements were performed at the UltraTech's 3 Meter Open Field Test Site (OFTS) situated in the Town of Oakville, province of Ontario. The Attenuation Characteristics of OFTS have been filed to FCC, Industry Canada, ACA/Austel, NVLap and ITI.
- Radiated emissions measurements were made using the following test instruments:

1. Calibrated EMCO BiconiLog antenna in the frequency range from 30 MHz to 2000 MHz.
2. Calibrated Emco Horn antennas in the frequency range above 1000 MHz (1GHz - 40 GHz).
3. The test is required for any spurious emission or modulation product that falls in a Restricted Band, as defined in Section 15.205. It must be performed with the highest gain of each type of antenna proposed for use with the EUT. Use the following spectrum analyzer settings:

   - RBW = 100 kHz for f < 1GHz and RBW = 1 MHz for f $\geq$ 1 GHz
   - VBW = RBW
   - Sweep = auto
   - Detector function = peak
   - Trace = max hold
   - Follows the guidelines in ANSI C63.4-1992 with respect to maximizing the emission by rotating the EUT, measuring the emission while the EUT is situated in three orthogonal planes (if appropriate), adjusting the measurement antenna height and polarization, etc.. A pre-amp and highpass filter are required for this test, in order to provide the measuring system with sufficient sensitivity.
   - Allow the trace to stabilize.
   - The peak reading of the emission, after being corrected by the antenna correction factor, cable loss, pre-amp gain, etc…. is the peak field strength which comply with the limit specified in Section 15.35(b)

   Calculation of Field Strength:

   The field strength is calculated by adding the calibrated antenna factor and cable factor, and subtracting the Amplifier gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

$$FS = RA + AF + CF - AG$$

Where FS = Field Strength
RA = Receiver/Analyzer Reading
AF = Antenna Factor
CF = Cable Attenuation Factor
AG = Amplifier Gain

Example: If a receiver reading of 60.0 dBµV is obtained, the antenna factor of 7.0 dB/m and cable factor of 1.0 dB are added, and the amplifier gain of 30 dB is subtracted. The actual field strength will be:

Field Level = 60 + 7.0 + 1.0 - 30 = 38.0 dBµV/m.
Field Level = $10^{(38/20)}$ = 79.43 µV/m.

- Submit this test data
- Now set the VBW to 10Hz, while maintaining all of the other instrument settings. This peak level, once corrected, must comply with the limit specified in Section 15.209. If the dwell time per channel of the hopping signal is less than 100ms, then the reading obtained may be further adjusted by a "duty cycle correction factor", derived from 10log(dwell time/100mS) in an effort to demonstrate compliance with the 15.209.
- Submit test data

Maximizing The Radiated Emissions:

- The frequencies of emissions was first detected. Then the amplitude of the emissions was measured at the specified measurement distance using required antenna height, polarization, and detector characteristics.
- During this process, cables and peripheral devices were manipulated within the range of likely configuration.
- For each mode of operation required to be tested, the frequency spectrum was monitored. Variations in antenna heights (from 1 meter to 4 meters above the ground plane), antenna polarization (horizontal plane and vertical plane), cable placement and peripheral placement were explored to produce the highest amplitude signal relative to the limit.

  The maximum radiated emission for a given mode of operation was found by using the following step-by-step procedure:

  Step1: Monitor the frequency range of interest at a fixed antenna height and EUT azimuth.

  Step2: Manipulate the system cables to produce highest amplitude signal relative to the limit. Note the amplitude and frequency of the suspect signal.

  Step3: Rotate the EUT 360 degrees to maximize the suspected highest amplitude signal. If the signal or another at a different frequency is observed to exceed the previously noted highest amplitude signal by 1 dB or more, go back to the azimuth and repeat Step 2. Otherwise, orient the EUT azimuth to repeat the highest amplitude observation and proceed.

  Step4: Move the antenna over its full allowable range of travel (1 to 4 meters) to maximize the suspected highest amplitude signal. If the signal or another at a different frequency is observed to exceed the previously noted highest amplitude signal by 1 dB or more, return to Step 2 with the highest amplitude observation and proceed.

  Step5: Change the polarization of the antenna and repeat Step 2 through 4. Compare the resulting suspected highest amplitude signal with that found for the other polarization. Select and note the higher of the two signals. This signal is termed the highest observed signal with respect to the limit for this EUT operational mode.

  Step6: The effects of various modes of operation is examined. This is done by varying the equipment modes as steps 2 through 5 are being performed.

After completing steps 1 through 6, record the final highest emission level, frequency, antenna polarization and detector mode of the measuring instrument.